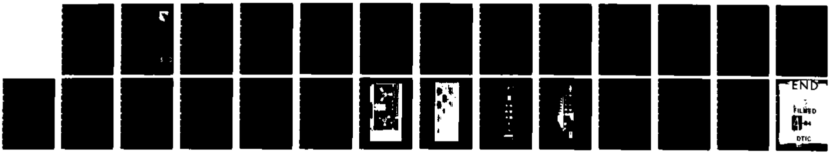
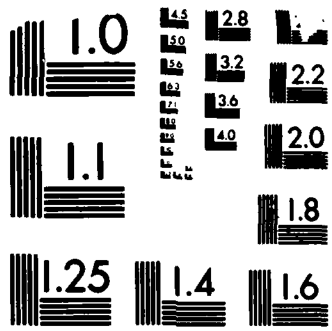
AD-A138 344 FEASIBILITY DEMONSTRATION OF A TARGET CUER SIMULATOR (U) SYSTEMS RESEARCH LABS INC DAYTON OH D E LEWIS OCT 83 AFAMRL-TR-83-084 F33615-82-C-0511 1/1

UNCLASSIFIED F/G 5/8 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

12

AFAMRL-TR-83-084

AD A138344

FEASIBILITY DEMONSTRATION OF A TARGET CUER SIMULATOR

DR. DONALD E. LEWIS

SYSTEMS RESEARCH LABORATORIES, INC.
2800 INDIAN RIPPLE ROAD
DAYTON, OH 45440

OCTOBER 1983

Approved for public release; distribution unlimited.

AIR FORCE AEROSPACE MEDICAL RESEARCH LABORATORY
AEROSPACE MEDICAL DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

NOTICES

TECHNICAL REVIEW AND APPROVAL

AFAMRL-TR-83-084

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

CHARLES BATES, JR.
Director, Human Engineering Division
Air Force Aerospace Medical Research Laboratory

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER AFAMRL-TR-83-084	2. GOVT ACCESSION NO. AD-A138 344
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) FEASIBILITY DEMONSTRATION OF A TARGET CUER SIMULATOR	5. TYPE OF REPORT & PERIOD COVERED Technical Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Dr. Donald E. Lewis*	8. CONTRACT OR GRANT NUMBER(s) F33615-82-C-0511
9. PERFORMING ORGANIZATION NAME AND ADDRESS AFAMRL, Human Engineering Division, AMD, AFSC, Wright-Patterson AFB OH 45433	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62202F, 7184-11-45
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE October 1983
	13. NUMBER OF PAGES 27
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

*The work reported herein was performed, in part, by Systems Research Laboratories, Inc., 2800 Indian Ripple Road, Dayton, Ohio 45440

AFAMRL Monitor: Gilbert G. Kuperman, AFAMRL/HEA, Tele: 513 255 7562

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Target Acquisition	Longitudinal Recording
Automatic Target Recognition	Video Processing
Cueing	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A requirement exists to "cue" or "highlight" specific objects or targets within a video scene, generally available on tape in the helical-scan format. Typically, this imagery would have originated in an airborne FLIR system moving at a high velocity with respect to the targets of interest, so that additional processing of the stored pictorial information dictates simultaneous slow motion reproduction, cue insertion, and rerecording. If multiple

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

(20. continued)

cues are needed, as is the case in studies of operator performance, this process results in a continual degradation of the video signal. Typical helical-scan machines do not provide the described capability.

A novel technique, utilizing a multichannel longitudinal tape format, has been devised and demonstrated to permit all the required modes of operation with little or no degradation of the original video signal. The operation of this system depends on the separation of the composite video signal into its constituent information and timing components for recording. The signals reproduced are then available for cue synchronization, processing, and ultimate recombination into the "cued" composite video signal.

SUMMARY

The widespread application of imaging sensors to target acquisition and weapon delivery missions has burdened the operator with the tasks of search, detection, and recognition. The accomplishment of these tasks requires that strict attention be paid to the sensor display. Further, since several seconds are required for each task, the aircraft must remain in an exposed position until they are sequentially completed. In order to alleviate these factors, emphasis is being placed on the development of automated target recognition subsystems which would identify, on the display, the locations of probable targets to the operator. He would then simply confirm or deny the target cue. In the development of such devices, two specifications are expected to have great impact on the cost/complexity of the processor and on the behavioral performance of the operator: false alarm rate and missed target rate. The first type of error results in the generation of a cue to a nontarget while the second is the absence of a cue when a target is, in fact, present. Since no such devices have been developed to date, a simulation capability is required to support investigations of the sensitivity of the operator to cuer capabilities and limitations.

PREFACE

This report documents a simulation technique survey and limited scope feasibility demonstration performed by the Visual Display Systems Branch, Human Engineering Division of the Air Force Aerospace Medical Research Laboratory (AFAMRL), under Work Unit 71841145. This work was performed, in part, at the request of the Electro-Optics and Reconnaissance Branch of the Air Force Wright Aeronautical Laboratories (AFWAL). The effort was supported by Systems Research Laboratories, Inc., Dayton, Ohio, under Air Force Contract No. F33615-82-C-0511. Mr. Robert Linhart, Technology Integration Branch, Human Engineering Division, is the Air Force Contract Monitor.

The author wishes to express his appreciation to Mr. William N. Kama, the AFAMRL Work Unit Manager; to Mr. Gilbert G. Kuperman, the AFAMRL Principal Investigator; to Mr. Marvin D. Christopher, who made possible the feasibility demonstration; and to Capt. David Hake, Mr. Andrew Grandjean, and Mr. David Power (all AFWAL), who supported and encouraged the effort.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

Section 1

INTRODUCTION

The duties of a FLIR operator during a mission may be many and complex. The resulting division of attention, particularly under time constraint, may be so severe that the ability to detect, recognize, and visually track military targets on the display is seriously degraded. For this reason, development efforts have been initiated to automatically locate military targets on the display, by means of digital processing, and provide the operator with a visual cue or distinctive marking of each target on the display. Here, of course, "target" means each object in the field of view which satisfied predetermined criteria used to define a target.

Previous work (1, 2, 3, 4, 5, 6, and 7) has shown that many criteria sets exist for defining targets and that many data processing algorithms can be applied to picture data. However, only limited investigation has been performed to evaluate the effect of cuer parameters, such as false alarm rate or missed target rate on FLIR operator performance or mission effectiveness. The results of such an investigation would be important in the final implementation of a cueing system or in the process of selecting one of a number of competing concepts for final implementation.

For this reason, a requirement has been established for a FLIR Cuer Simulation Facility by joint agreement between the Air Force Wright Aeronautical Laboratories and the Air Force Aerospace Medical Research Laboratory. In the definition of the Simulation Facility, it was determined that the target to be cued would be contained in videotape or video cassette data obtained during flight tests of appropriate U.S. Air Force sensor systems. The simulated cue was defined as a rectangular white outline somewhat larger than, and surrounding the target, positioned manually and recorded with the original scene. As many as five cues were specified for each tape sequence of approximately 30-seconds duration.

For purposes of realism, it was further stipulated that for some missions, the recorded FLIR motion with respect to the targets to be cued would occur at such a high rate that real-time manual insertion of the cue symbol would not be possible. This high rate of relative motion imposes a degree of complexity on the attainment of the desired capability such that standard, relatively low cost ivdeo recording techniques could not be used to generate the imagery required for the Simulation Facility.

Therefore, configuration of the required Simulation Facility was found to depend on a demonstration of the feasibility of apparatus for the purpose of:

1. Slow motion playback of videotaped imagery not using skipped-frame techniques, with

2. Simultaneous synchronized recording of the required cues, one per tape run, while

3. Providing little or no degradation of the original imagery caused by sequential rerecording, and

4. Providing the capability to select the number and/or locations of cues included in any individual simulated mission.

A requirement for the use of off-the-shelf technology was also established.

Section 2

TECHNOLOGY EVALUATION

During the definition phase of this study, an experimental attempt to realize the required recording capability using two video cassette recorders capable of slow speed operation produced unacceptable results. Careful observation of the display obtained led to the conclusion that temporal synchronization was inadequate with each machine running independently. The use of two externally synchronized capstan-servoed helical-scan machines, with an external editing system, might lead to better results, at a much higher cost. It was perceived, however, that the original video scene would be rerecorded as each cue was added, resulting in the undesirable degradation of the original imagery. Low probability of achieving an acceptable display was assigned to this implementation.

Video disc devices find wide application in real-time record, slow motion playback operations, and so were investigated. It was found that, in their standard off-the-shelf configuration, these machines only record in real-time, and only playback in slow motion. Two-channel operation is feasible, so that minor modifications may have produced the desired characteristics. However, this mode is restricted to a 15-second operating time. Because of the uncertainties and the relatively high cost, this implementation was assigned a low evaluation rating.

Multichannel longitudinal recorder/reproducer devices are widely available commercially and typically possess bandwidths that are suitable for video scene recording. The devices are frequently called "instrumentation recorders" and are not, according to those skilled in their use, appropriate for picture recording. It has been generally assumed that longitudinal recording (similar to audio tape recording) of video scenes is not possible.

Typically, this assumption has been applied without any further consideration of the framework in which it was originally formulated. Indeed, picture recording and reproduction from a longitudinal recorder employing the technology of two to three decades ago is not possible with:

1. Broadcast Quality Composite Signals

2. Sync Signals Meeting EIA Specifications

3. A Standard Monitor Reproducing the Picture

These qualifications do not apply in the present applications. Therefore, a preliminary design of the required picture processing system was undertaken.

The technology described here has been the basis for the award of a U.S. Patent (No. 4,377,824, 22 March 1983), and the subject of considerable interest. However, no application of the technology has been made in AFAMRL because the original requirement for the technology, generated by AFWAL, has been withdrawn. While other applications could have been satisfied within AFAMRL, the high cost of the instrumentation recorder required for this technology has resulted in the selection of more cost-effective techniques with attendant lower capabilities than those developed under this effort.

Section 3

SYSTEM DESIGN

A typical longitudinal machine has 14 channels available (although fewer or more channels are common). In consideration of the assumption cited earlier (which is easily confirmed experimentally), five channels should be used to record the original video scene--one channel for the video signal only and one for each timing signal (i.e., sync, V-drive, H-drive, and blanking). The spatial registration produced on recording assures temporal simultaneity on playback in spite of tape stretch, etc.

These channels may then be reproduced by the machine to form a display on which a cue may be inserted. The cue video signal is simultaneously recorded on one of the nine available tracks. The five required cues are recorded on five tracks, in spatial registration with the original video scene, in this manner. In the remaining four tracks, the existing five cues can be rerecorded in appropriate groups. Since the cues are merely white rectangles, their signals can be "sharpened" by simple means during the rerecording process so that no degradation occurs.

The display of the composite signal obtained during slow motion reproduction by a standard video monitor will not be satisfactory since these monitors are ordinarily configured to operate only with properly timed signals. Here, properly timed means 30 frames per second. Thus, for the intermediate tape processing tasks, the display is formed by an X-Y monitor using the recorded video scene as the Z-axis signal, and ramps timed by the H-drive and V-drive signals on the X channel and Y channel, respectively. This display setup gives usable reproductions over a wide range of playback speeds.

The system designed is being described by the functional block diagrams that follow.

Figure 1 depicts the recording process for the "original" or "master" video signal on five channels of the longitudinal recorder. The picture signal is recorded on channel A, the blanking pulse on channel B, composite sync on channel C, V-drive on channel D, and H-drive on channel E. The means for deriving the required timing signals are indicated. The vertical drive pulse occurs at a low frequency, outside the direct record bandwidth of the longitudinal recorder. For this reason, the channel D record and reproduce electronics must be the FM type, a standard option on longitudinal machines. The machine speed, S_1, may conveniently be 60 inches per second.

Figure 2 depicts real-time tape playback and cue insertion. The master video channels are played back and drive a video mixer. The timing signals also synchronize a "special effects generator," which provides the rectangular box cue as an output, both to the video mixer and to a machine record channel. Thus, the LTF is reproducing from channels A through E while recording on channel F. (Recording on some channels while playing back others is not a universal feature of longitudinal machines; it can generally be accomplished without major modification.) The video mixer output drives a conventional raster scan display with the sum signal, so that the cue can be positioned with respect to the target.

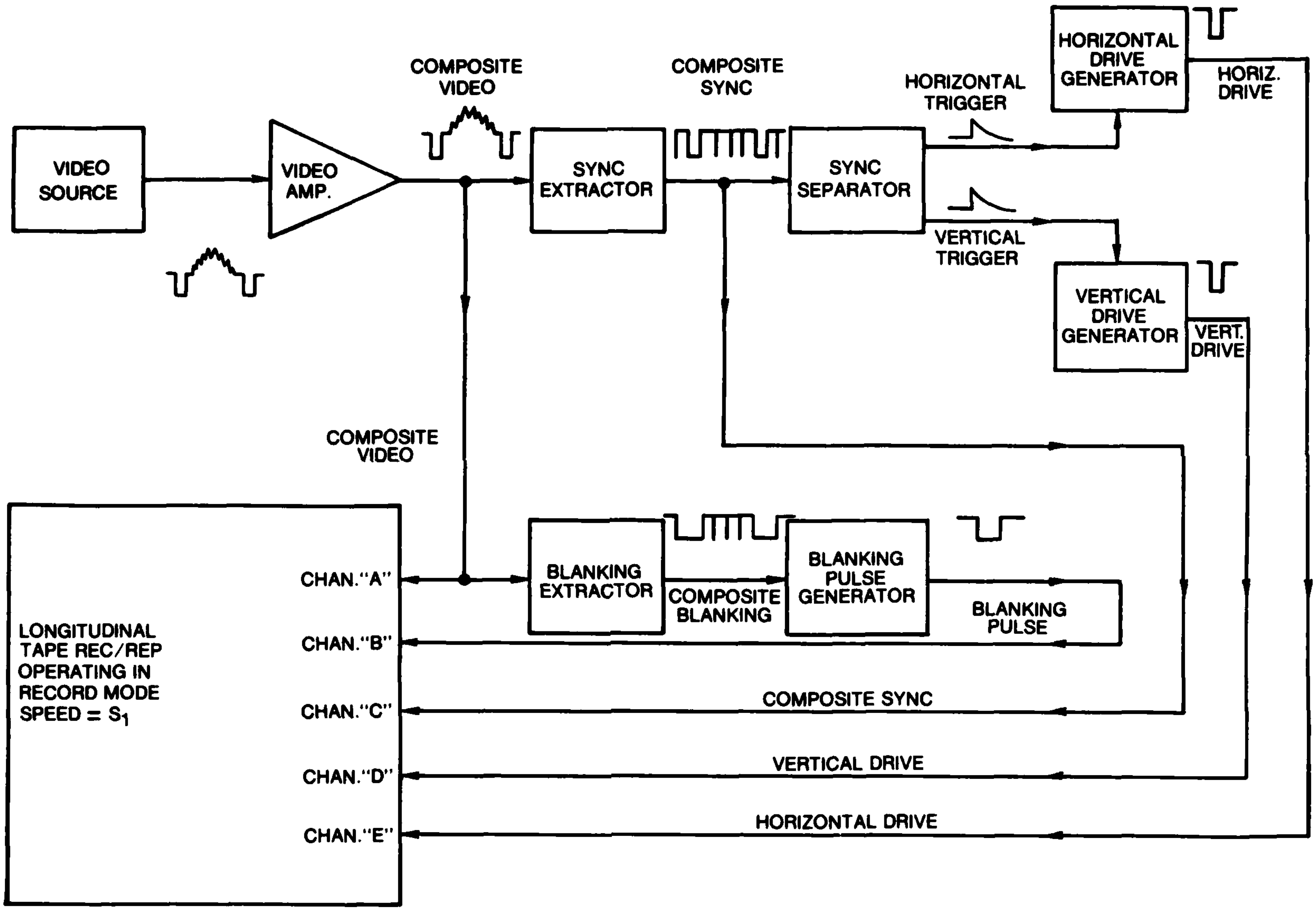


Figure 1. Functional Block Diagram for Longitudinal Tape Recording

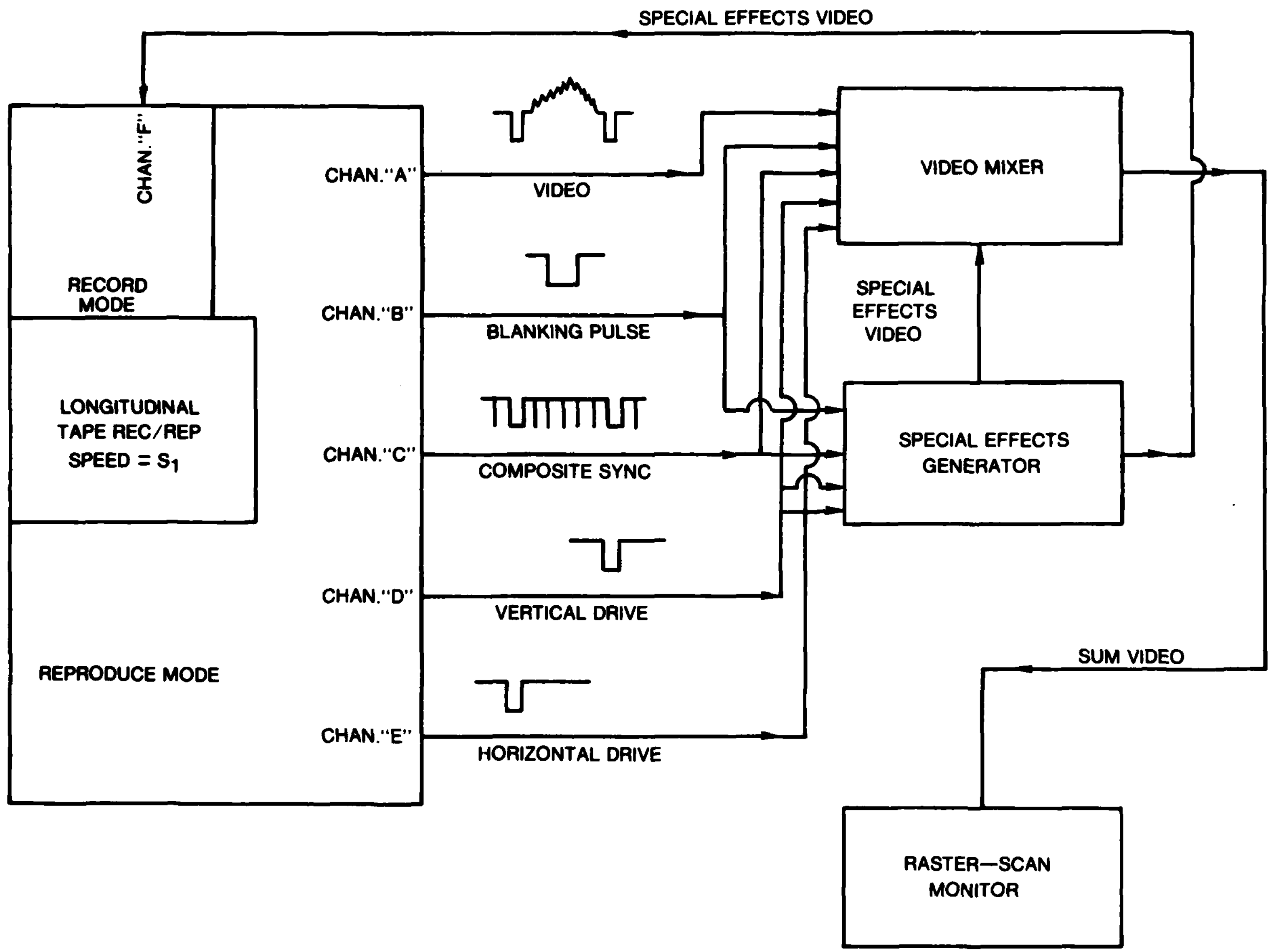


Figure 2. Functional Block Diagram for Real-TIme Longitudinal Tape Reproduction

Figure 3 depicts slow motion tape playback utilizing an X-Y monitor. This setup was used to confirm and adjust the operation of special circuitry for ramp generation and to study the nature of the display produced at various machine speeds. A video amplifier and inverter was also placed on the circuit board to allow for convenient signal balancing. Obviously, if the screen is to be filled by the display, the ramp slopes must be readjusted for each different machine speed, unless monitor gain adjustments are adequate for this purpose. Of course, as machine speed is slowed, the display brightness decreases; viewing in a darkened room may be necessary. In general, however, the display produced is adequate and is certainly usable for the purposes under consideration here.

Figure 4 depicts the ultimate tape processing system. Again, channels A through E contain the master video signals, recorded as shown in Figure 1. Provision is made for a special effects generator to provide the cue; and a second video source, synchronized by the recorded timing signals, may be used to insert other special purpose video signals. The raster scan monitor is used for real-time playback; otherwise, the X-Y monitor is used. It is important to note that rerecording of the master picture signal is never required in the tape processing operation. In fact, all the requirements given for the system are met by this implementation.

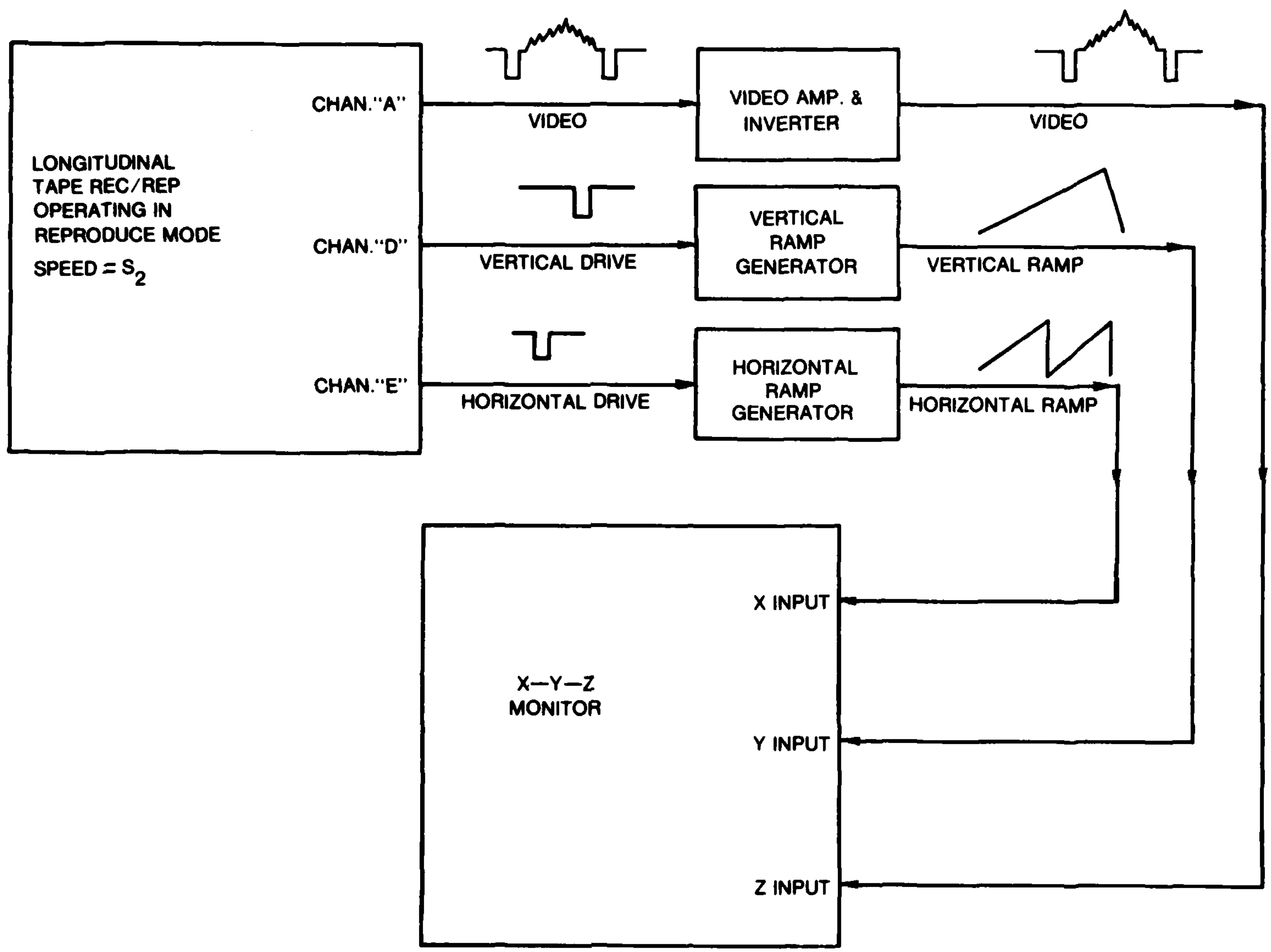


Figure 3. Functional Block Diagram for Slow Motion Longitudinal Tape Reproduction

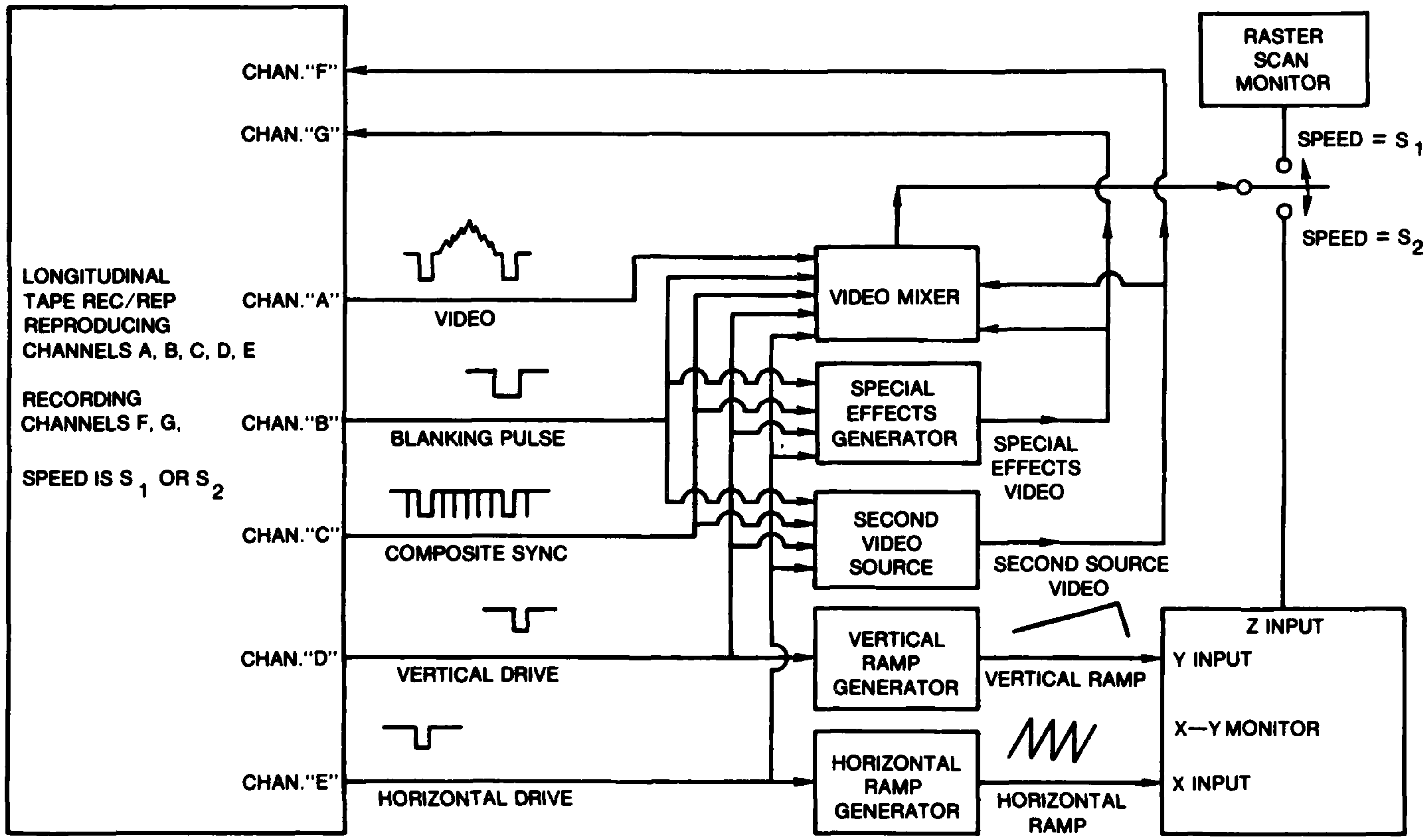


Figure 4. Functional Block Diagram of System for Producing a Simulation of Cued Sensor Imagery

Section 4

SYSTEM TESTING

During the course of this investigation, an approach to satisfying the requirements of the Air Force Wright Aeronautical Laboratories for the FLIR Cuer Simulation Facility was identified and the design pursued to the component specification level. Fortuitously, at the conclusion of the conceptual design of the system, contacts with the Signal Operations Branch of the Air Force Foreign Technology Division disclosed a long standing interest in capabilities identical to those established here. In support of the effort, an instrumentation recorder was furnished on loan to allow for a laboratory evaluation of the concepts developed. The Display Laboratory of the Visual Display Systems Branch, Air Force Aerospace Medical Research Laboratory, in which the experimentation was accomplished, contained most of the other required equipment.

The first phase consisted of using the setup of Figure 1 to record a video signal (an off-the-air commercial broadcast was the source). Rather than the extractors shown in Figure 1, a gen-locked sync generator was used to provide the timing signals. This is, of course, possible with a broadcast signal because of its excellent timing; no difficulty in achieving gen-lock was encountered. It was, however, necessary to carefully adjust each record and reproduce channel of the instrumentation recorder, shown in Figure 5, in both gain and dc level to obtain usable reproduction. Since the recorder utilized automatically plays back during recording, the setup of Figure 2 was used simultaneously to review the result. After a concentrated period of adjustment and readjustment, successful operation was established and maintained.

The second phase required demonstration of similar operation using typical mission tapes as the source, reproduced by a video cassette recorder. Since the timing signals obtained in this manner are much less stable than those obtained from a broadcast source, gen-lock could not be achieved; and usable recordings could not be made. Therefore, the sync extractor circuitry was obtained to replace the gen-lock sync generator. In this configuration, successful recording and reproduction of the mission tapes was established without difficulty. Figure 6 depicts the playback signals obtained from this system. Figures 7 and 8 are front and rear views, respectively, of the sync stripper and the combined special effects generator/video mixer.

The third phase required demonstration of the setup of Figure 3 and the required slow motion mode of operation. The required circuits for ramp generation and video amplification were deigned and constructed, and the system connected. Satisfactory operation at various speeds was obtained without undue difficulty. The display obtained in this mode has been superior, in most respects, to that obtained using a raster scan monitor, which contains some timing error artifacts. Of course, the X-Y monitor is entirely controlled by the reproduced tape signals, so that "timing error" is not a well-defined concept.

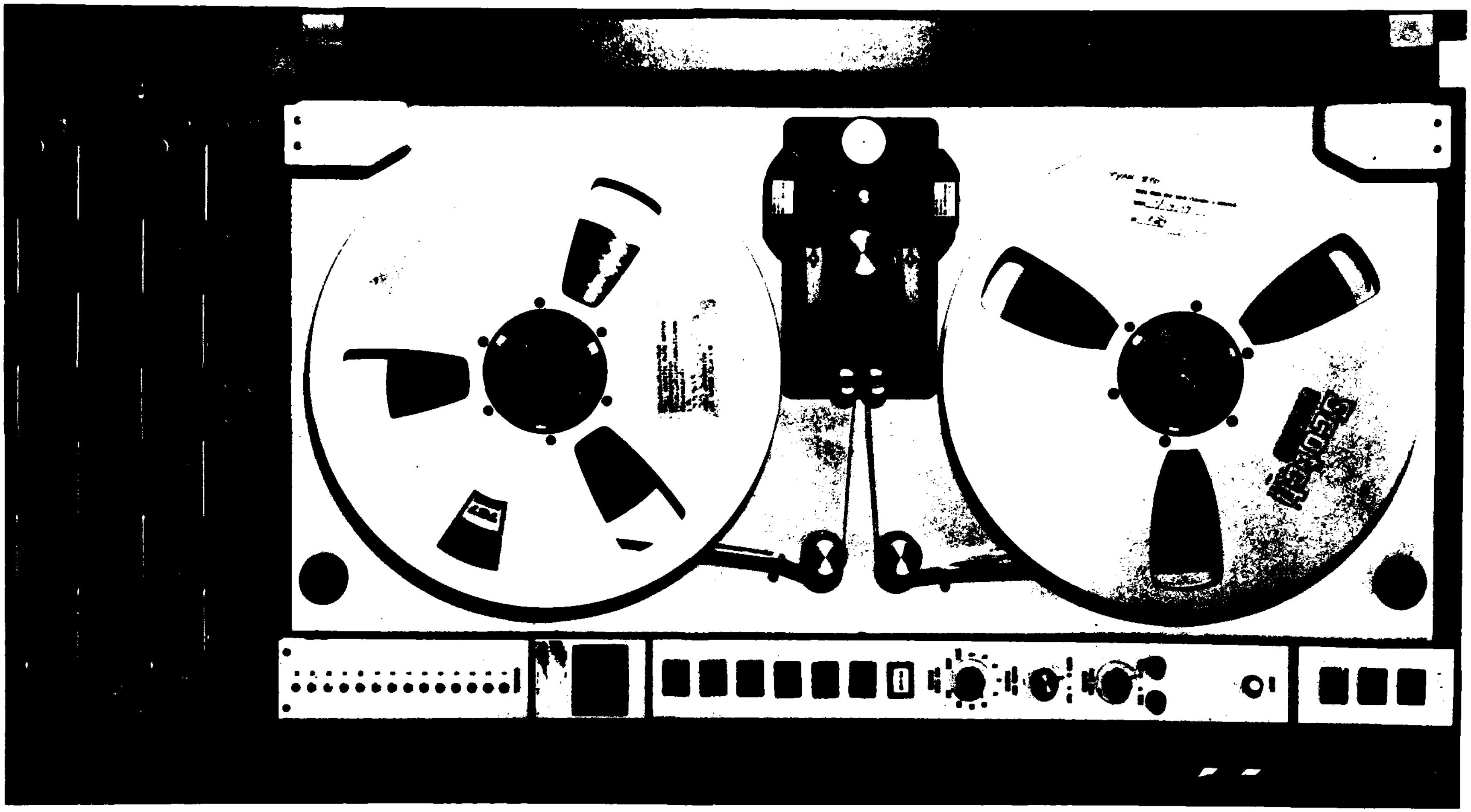


Figure 5. Front View of Longitudinal Recorder/Reproducer Used in Experimentation

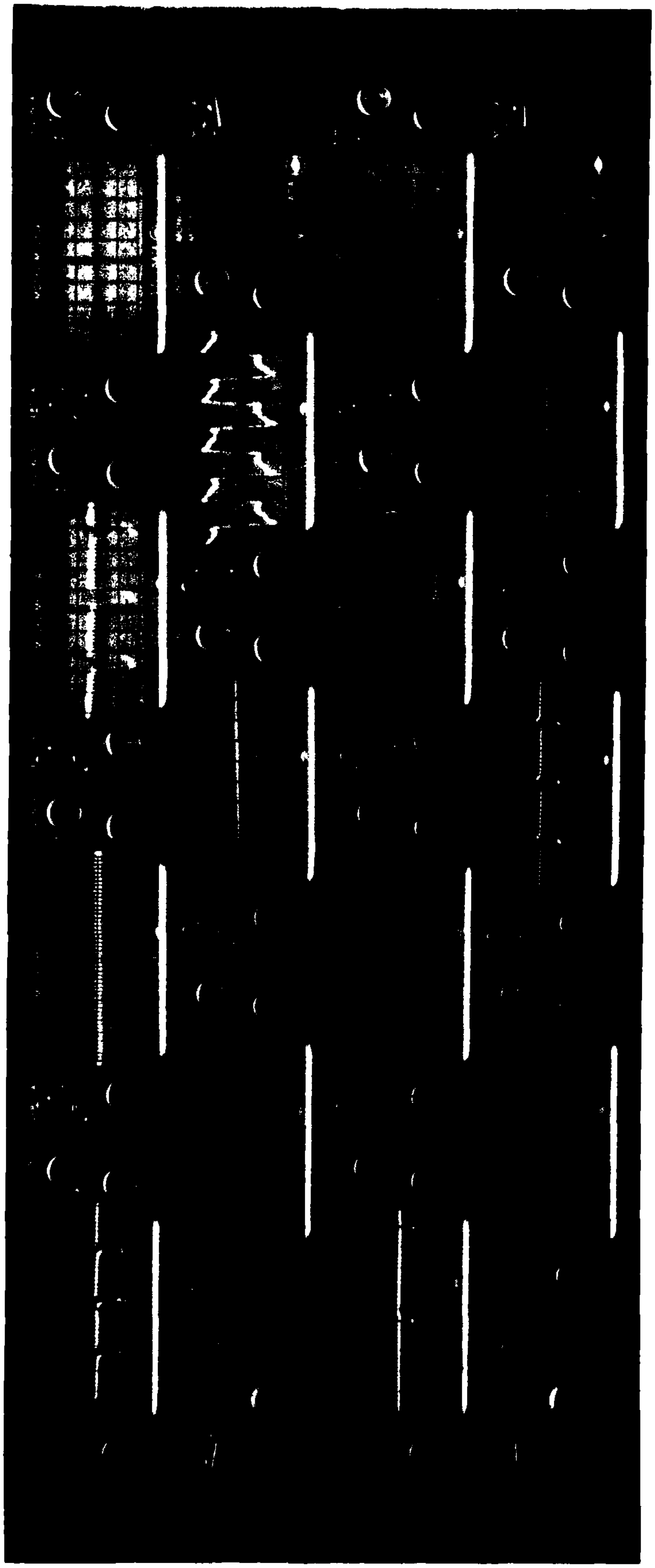


Figure 6. System Playback Signals

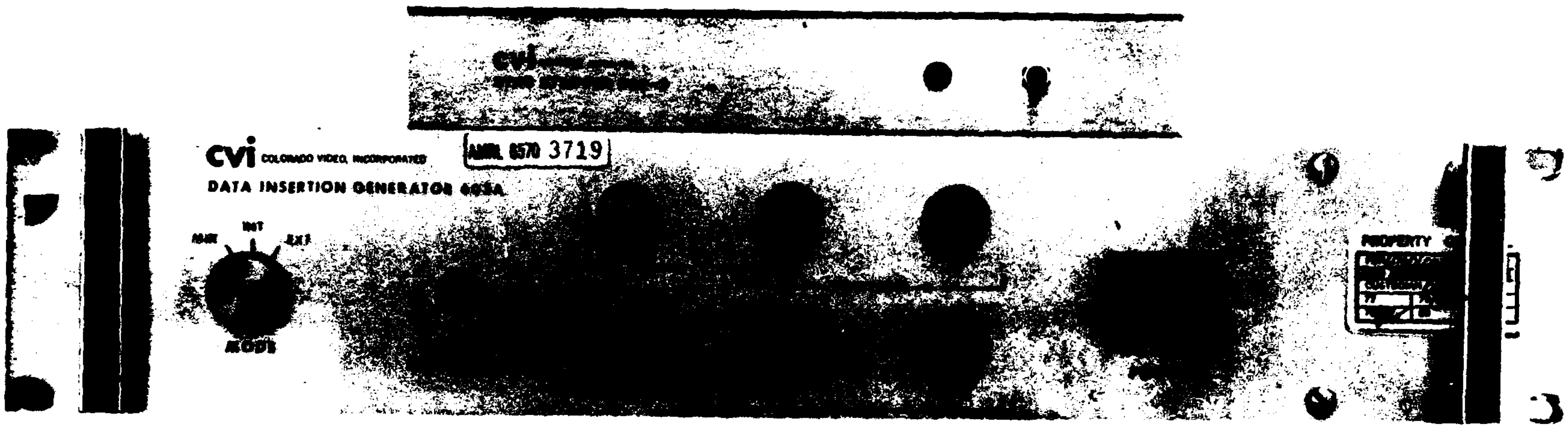


Figure 7. Cueing Circuitry--Front View

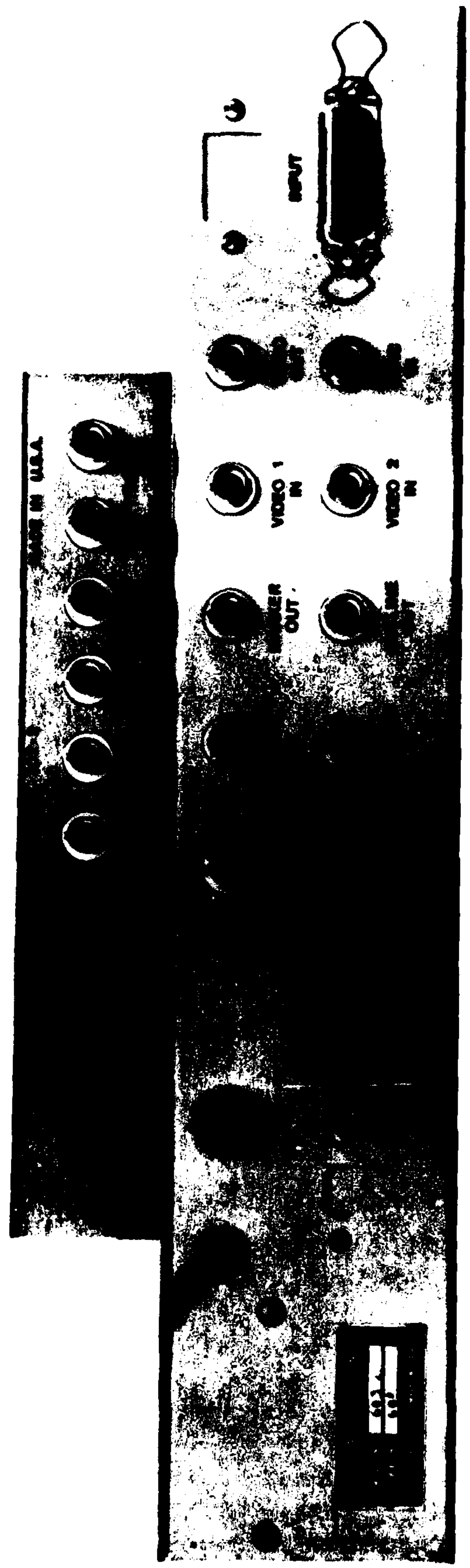


Figure 8. Cueing Circuitry--Rear View

Section 5

FUTURE EFFORT

The logical fourth phase of system testing would be to implement the setup of Figure 4 and demonstrate the processing of a typical simulator test tape. There has been, however, a natural reluctance to modify the instrumentation recorder on loan from FTD; and it is not configured to record in its playback mode. In addition, this recorder does not typify current technology, so that extensive time spent on modifications could well be wasted.

The desired course of action requires the purchase of a new recorder/reproducer, appropriately configured by the manufacturer for the applications described here. Assuming the availability of appropriate auxiliary equipment and work space, the versatility and applications of the truly unique capabilities developed and demonstrated here could be thoroughly explored.

Section 6

CONCLUSIONS

The successful design and development of a system for longitudinal tape recording of video scenes represents an important technological event. The rejection of the technique some years ago was well founded and proper at the time. In the intervening years, however, the uses of and needs for video displays have evolved from almost exclusively commercial broadcast applications to a myriad of new, special purpose systems, typified by the FLIR Cuer Simulation Facility. Since most videotaping equipment has developed along lines of compatibility with broadcast signals, flexibility is generally at a minimum. The capability described here, which could produce 10 or more perfectly synchronized channels of video scenes simultaneously, capable of being play at various speeds, would seem to have applications in military systems, educational systems, medical systems, etc.

REFERENCES

1. Alburn, D. M. and W. S. McCormick, April 1970, "Performance Probabilities of Multichannel TV and Line Scanners as Multispectral Cueing Systems," Technical Report AFAL-TR-69-304.

2. Swanlund, G. D., October 1974, "Augmented Target Screener Subsystem (ATSS)," Technical Report AFAL-TR-74-184.

3. Geokezas, M., February 1976, "FLIR Image Analysis with the Autoscreener Simulation (Volume I)," USA Night Vision Laboratory Technical Report.

4. Tack, D. H. and P. Narenda, December 1976, "Automated Image Enhancement Techniques--2nd Generation FLIR," USA Night Vision Laboratory Technical Report (ADA 035627).

5. Narenda, P. M., L. G. Williams, and W. G. Chaplin, May 1977, "Automated Image Enhancement Techniques for Second Generation FLIR," USA Night Vision Laboratory Technical Report (ADA 041034).

6. Hoyt, R. R. and W. J. Miller, April 1977, "Digital Cueing Final Report," Rome Air Development Center Tehcnical Report, RADC-TR-77-44, Volumes I and II.

7. Tisdale, G. E. and T. P. Truitt, May 1976, "Demonstration of Westinghouse Automatic Cueing Techniques Using NVL Imagery," USA Night Vision laboratory Technical Report (ADA 036538).

☆ U.S. GOVERNMENT PRINTING OFFICE: 1984-760-502/197

FILME

4-84